Steam Generator Action Plan
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Briefing for the ACRS
Materials and Metallurgy Subcommittee
September 26, 2001

Maitri Banerjee, NRRIDLPM

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Historical Overview

ò 2/15/00 - 1P2 Tube Failure Event
ò 2/28/00 - NRR request to RES for independent review
ò 3/16/00 - RES response to NRR
ò 5/24/00 - Task Group Charter issued
ò 8/29/00 - OIG Report issued
ò 8/30/00 - Chairman's request for staff review of OIG Report
ò 10/23/00 - Lessons-Learned Report issued
ò 1113/00 - Staff Review of OIG Report issued
ò 11/16/00 - Steam Generator (SG) Action Plan issued
ò 2/1/01 - ACRS Ad Hoc Subcommittee Report issued
ò 3/5/01 - EDO tasking memo on ACRS Report (SG DPO)
ò 5/11/01 - SG Action Plan revised (SG DPQ issues)

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SG Action Plan - Purpose ___

ò SG Action Plan was issued on 11I16IOO~ The purpose of the action plan is to:

Direct and monitor the NRC's efforts

Ensure issues are appropriately tracked and dispositioned

Ensure the NRC's efforts result in an integrated SG regulatory framework

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SG Action Plan - Scope

ò Consolidates numerous activities related to SGs:

Recommendations from Task Group report
Recommendations from the QIG report
NEI 97-06, "Steam Generator Program Guidelines"
Resolution of SG DPO
~GSI-1 63, "Multiple Steam Generator Tube Leakage"

ò Anticipate revision to include resolution of GSI-1 88, "SG Tube Leaks/Ruptures Concurrent with Containment Bypass," and DG-1 073, "Plant Specific

Risk-Informed Decision Making : Induced SG Tube Rupture"

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SG Action Plan --

ò Also includes some non-SG related issues (e.g., Emergency Planning issues from OIG report)

ò Does not address plant-specific reviews or industry proposed modifications related to implementation of GL 95-05 (voltage-based tube repair criteria)

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SG Action Plan Status

òAction Plan dated 11/16/00 - 29 milestones

Items 1.1-1.21 (SG-related)14 of 21 complete
presently scheduled to be complete by 2/01/02
Schedule for NEI 97-06 items being reevaluated

Items 2.1 - 2.8 (non-SG related) 6 of 8 complete
scheduled to be complete by 02/02, except for one item TBD

òRevision dated 5/11/01 added 11 milestones
Items 3.1 -3.11 (SG DPO-related)
Scheduled to be complete by 12/31106

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SG Action Plan- Significant Activities

eRegulatory Issues Summary - SG Lessons Learned

òGujdance for NRC Inspectors

-Baseline inspection program
-Risk-informed SDP
-Inspector training
-Facilities with known SG tube leak

òSG Performance Indicators

òGuidance for review of licensee SG inspection results, conference calls during outages
òSG workshop with stakeholders

SGAP - Significant Activities (Cont'd)

ò Guidance for license amendment reviews

ò Review and develop SE for NEI 97-06

ò Establish SG Action Plan web page

ò Planned initiative on risk communication and outreach to the public

ò Milestones for ACRS recommendations on DPQ

ò Milestones for GSI 163,188, DG-1073

Action Plan - Management

ò Completion of significant milestones will be documented via memo from lead Division Director to Associatel Deputy Office Director

ò Resolution of issues will be coordinated with internal and external stakeholders

ò Status of milestones will be updated in Commission Tasking Memo, NRR Director's Quarterly Status Report, and RES Operating Plan

ò Overall management of the plan is the responsibility of DLPM

NEI Steam Generator Generic License Change Package

-Discussion

- NRC Review Status

ACRS Materials and Metallurgy Subcommittee

September 26, 2001

Ted Sullivan
Division of Engineering
Office of Nuclear Reactor Regulation
(301)415-2796

Background

ò Regulatory requirements for SG inspection/repair are prescriptive and out of date

- Requirements not focused on key objective of ensuring tube integrity for entire period between inservice inspections

- Meeting these requirements does not, in and of itself, ensure tube integrity is being maintained

ò Staff initiative for a revised regulatory framework has evolved over time

- Rulemaking
- Generic Letter
- Consideration of industry's NEI 97-06 initiative
- Review of NEI SG Generic Change Package (GCP)

NEI SG Generic Change Package (GCP)

- Initially submitted February 4, 2000
    - Revised submittal dated December 11, 2000
- Staff did not initiate review until January 2001
    - due to followup activities relating to IP-2 SG tube failure on February 15, 2000
- Staff's review of GCP has included consideration of issues identified in the staff's action plan, including:
    - NRC IP-2 SG Tube Failure Lessons Learned Report
    - Regulatory Information Summary (RIS) 2000-22
    - DPO Action Plan

NEI SG Generic Change Package (GCP) (Cont'd)

GCP represents the culmination of efforts to develop a revised and updated regulatory framework that include the following characteristics:

- performance based: establishes performance criteria for ensuring tube structural integrity and leakage integrity under normal and accident conditions
- performance criteria are in terms of parameters which are measurable and tolerable
- flexible: methods for meeting the performance criteria are up to the licensee
- adaptable to changing degradation mechanisms and technology
- risk informed: ensures no significant increase in risk

NEI SG Generic Change Package (GCP) (Cont'd)

Revised Technical Specifications:

- Revised LCO Spec for operational leakage: 500 gpd to 150 gpd
- New LCO Spec, "Steam Generator Tube Integrity"
    - SR: Verify performance criteria are met in accordance with Steam Generator Program
- New Administrative Tech Spec: "Steam Generator Program"

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New Administrative Tech Spec: "Steam Generator Program"

An SG Program shall be established and implemented to ensure SG tube integrity performance criteria are maintained

ò Condition monitoring assessments of as-found tube condition vs the performance criteria shall be performed at each SG inspection outage. Requirements for condition monitoring are defined in the SG Program

ò Use NRC approved performance criteria

ò Use NRC approved tube repair criteria and repair methods

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SG Program

ò Details of the SG program will be located outside of tech specs

ò Licensee's will commit to developing the SG Program in accordance with NEI 97-06

ò NEI 97-06 provides general guidance for a performance based, programmatic strategy for ensuring SG tube integrity. Programmatic elements include:

- performance criteria
- tube integrity assessment
- inservice inspection
- tube repair limits & repair methods
- leakage monitoring

ò NRC staff is reviewing NEI 97-06 for endorsement as part of its review of the NEI SG GCP

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Detailed EPRI Guideline Documents

NEI 97-06 references sub-tier, detailed EPRI guideline documents concerning each of the programmatic elements. These include:

- EPRI SG examination guidelines
- EPRI tube integrity assessment guidelines
- EPRI in-situ pressure test guidelines
- EPRI guidelines for monitoring primary-to-secondary leakage
- EPRI water chemistry guidelines

- EPRI sleeve and plug assessment guidelines

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Detailed EPRI Guideline Documents

It had not, initially, been the staff's intent to review or endorse the sub-tier, detailed EPRI guideline documents

- staff considers some of these guidelines to be "work in progress"

- staff expectation that guidelines would be sufficiently well developed to lead to improved tube integrity performance

- staff expectation that guidelines would continue to evolve over time in response to technology changes, lessons learned from operating experience, and results of industry and NRC studies (e.g., NRC SG mockup and ECT round robin, DPO action plan)

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Inspection Interval Issue

At the NRC SG Workshop in February 2001, industry representatives discussed draff revisions to the EPRI SG examination guidelines to permit inspection intervals for SGs with Alloy 600 TT or Alloy 690 TT tubing well beyond current EPRI guidelines and regulatory requirements:

- Initial industry draft would have permitted inspection intervals ranging to 22 EFPY

ò Staff is concerned that certain EPRI guidelines are not sufficiently well developed to ensure that inspection intervals beyond current requirements will be implemented so as to ensure that:

- tube integrity performance criteria will continue to be met

- tubing conditions not meeting the performance criteria will be promptly detected

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Inspection Interval Issue (Cont'd)

The staff has reviewed provisions of the EPRI guidelines critical to the effectiveness of condition monitoring (CM) to fulfill Appendix B obligation

- A number of issues in this respect identified (ltr. dated 8/2/01)

- Issues relate to industry practices that exist under the current regulatory framework and would continue to exist under the new framework

- These issues not expected to reduce assurance of tube integrity or increase risk under new regulatory framework, assuming inspection intervals do not increase relative to current requirements and practice

- However, the safety significance of these issues may be increased by longer inspection intervals depending on the specific methodology employed to justify the intervals

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Inspection Interval Issue (Cont'd)

The staff has also reviewed most of the industry responses to issues identified in the NRC IP 2 Lessons Learned Report and in RIS 2000-22

- Preliminary findings documented by 8/2101 letter to NEI

- These issues also relate primarily to the EPRI guidelines, and some overlap issues above on CM and inspection intervals

- The staff finds that a number of these issues remain unresolved, including issues extending beyond CM and inspection intervals

- Issues not expected to reduce assurance of tube integrity or increase risk under new regulatory framework, assuming inspection intervals do not increase relative to current rqmts. and practices

- Safety significance of additional issues may be increased by longer inspection intervals for plants with degradation activity depending on the specific methodology employed to justify the intervals

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Preliminary Conclusion

ò Pending resolution of the guideline issues, the staff has concluded preliminarily that it can proceed with review and approval of the GCP provided appropriate licensing restrictions are maintained on inspection intervals

  - The GCP would reduce assurance of tube integrity only in cases where longer inspection intervals than currently permitted are implemented without adequate justification.

ò NRC staff is exploring with the industry alternatives to current requirements, particularly for improved tube materials, pending resolution of the guideline issues with reasonable assurance that the tube integrity performance criteria will be maintained

ò NRC staff is working with industry to establish a protocol agreement for resolving outstanding technical issues (current and future)

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NRC Review Status

ò The staff is working with the industry to identify acceptable inspection interval restrictions

- GCP would need to be revised accordingly

ò Staff plans to issue SE concerning the GCP in a Regulatory Issue Summary (RIS)

- Drafts of the SE and RIS will be issued for public comment

- Target Date for Completion: Previous target of 10/31/01 has slipped six months due to the inspection interval issue. New target date is April 2002. This is contingent, of course, on resolution of the inspection interval issue in the very near term

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ACRS MATERIALS AND METALLURGY SUBCOMMITTEE

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September 26, 2001

Office of Nuclear Regulatory Research
Status of Action Plan DPO Issues
September 26, 2001

Joseph Muscara, Division of Engineering Technology7 RES - Materials Engineering Overview and Current Results
301-415-5844

Charles Tinkler, Division of Systems Analysis and Regulatory Effectiveness, RES - Severe Accidents and Thermal Hydraulics Overview
301-415-6770

Stephen Bajorek, Division of Systems Analysis and Regulatory Effectiveness, RES - Thermal Hydraulics
301-415-7574

Christopher Boyd, Division of Systems Analysis and Regulatory Effectiveness, RES - CFD Predictions
301-415-0244

SG Action Plan Milestones Associated with the DPO - Materials Engineering

3.1: Crack Propagation in SG tubes from pressure and MSLB loads

- Obtain loads, including cyclic loads, acting on tubes during MSLB from thermal-hydraulic calculations 12/31/02

- Obtain load and displacement information experienced by SG structures under MSLB conditions from existing analyses and submittals 12/31/02

- Using above information estimate upper bound loads, cycles and displacements 12/31/02

- Estimate crack growth, if any, for a range of crack types and sizes using the bounding loads, displacements and cycles in addition to the pressure stresses 12/31/02

3.1: Crack Propagation in SG tubes from pressure and MSLB loads (Cont.)

- Estimate loads required to propagate a range of axial and circumferential cracks and compare to MSLB loads (Margins) 12/31/02

- Conduct tests of degraded tubes under pressure and with axial and bending loads to validate the analytical results 06/30/03

3.2: Damage Progression Via Jet Cutting

- Complete tests of jet impingement under MSLB conditions 12/31/01

- Conduct long duration tests of jet impingement under severe accident conditions 12/31/01
- Draft reports 12/31/01

Jet Impingement and the Potential for Propagation of Failure

In NUREG-1570 the issue of propagating failures due to erosion by steam jets or high temperature gas/particle streams was considered.

ò Additional experiments to address jet cutting issues were performed.
  - High temperature tests, representative of severe accident conditions performed by W Tabakoff at University of Cincinnati

  - Steam jet erosion tests, representative of design basis accident conditions performed at Argonne National Laboratory

ò Initial results indicated low erosion rates (10 mm test)

  - ACRS suggested longer term tests to verify rates were steady state

Longer tests (30 mm) gave data indistinguishable from shorter tests

ò High Temperature Erosion Tests

- Particle loading due to aerosol transport from the molten core. Accident analyses suggest

Particulate in jet consists primarily of Ag plus lesser amounts of 1n203, CsMoO4, 5n02, OsI, and other species
Median particle diameter is %1 .5 [im, bulk of particles < 3 ~m

- Surrogate particles Ni and NiO were chosen for the tests. Particle sizes were taken as 3-7 i~m. In terms of size (larger particles are more damaging) and hardness at temperature~ the surrogate particles should give conservative estimates of erosion rates.

Initial tests with NiO gave deposition rather than erosion.
Subsequent tests were performed with Ni + 15% A1203.
High hardness and angularity of A1203 particles additional conservatism.

Erosion rates with Ni + 15% A1203 about 2.4 times higher than Ni

36: Improvements Over Use Of a Constant POD

- Complete analysis and document research results from the SG mockup NDE Round Robin 12/31/01

3.10: Stress Corrosion Cracking

- Conduct tests to evaluate crack initiation~ evolution and growth 12/31/05

- Use operating experience and results from laboratory testing to develop models for predicting cracking behavior of SG tubes in the operating environment 12/31/06

Severe Accident and Thermal Hydraulic Analysis
of Steam Generator Tube Conditions
to Address Differing Professional Opinion on
Steam Generator Tube Integrity

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Presentation to the Advisory Committee on Reactor Safeguards
September 26, 2001

Charles G. Tinkler
Safety Margins and Systems Analysis Branch
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

Recommendations of the
ACRS Ad Hoc Subcommittee on a
Differing Professional Opinion (Steam Generator Tube Integrity)

Severe and Design Basis Accident Conditions

ò Develop a better understanding of the behavior of degraded steam generator tubes under severe accident conditions

- Specifically addressed by SGAP Item 3.4

ò Evaluate the potential for progression of damage to (multiple) steam generator tubes during rapid depressurization caused by a main steamline rupture~

- Specifically addressed by SGAP Item 3.1

Steam Generator Action Plan

Task 3.4 Develop better understanding of reactor coolant conditions and the corresponding component behavior (including steam generator tubes) under severe accident conditions.

ò Major components of research
- System level code analysis (SCDAPIRELAP)
- Computational fluid dynamics (CFD) code analysis (FLUENT)
- Assessment of 117th scale data
- New experimental data

Severe Accident Issues

ò Plant design differences - System level analysis
ò Plant sequence variations - System level analysis
ò Uncertainty analysis quantified for - System level analysis
system level mixing parameters
- Core melt progression uncertainty
ò Loop seal clearing - System level analysis
ò Effect of tube leakage on - CFD analysis, considering testing
Inlet plenum mixing
ò Hot leglinlet plenum orientation - CFD analysis, considering testing
ò Tube to tube variations CFD analysis, considering testing
FP deposition - Planned testing (ARTIST)

Steam Generator Plan Activities - Severe Accident

Task 3~4 Near term items

Subtask 3.4a Perform system level analyses to assess impact of plant sequence variations. Due October 2001.

ò Reactor coolant pump seal leakage

ò Tube leakage

ò Alternate steam generator depressurization

ò Calculations completed, report in progress, on schedule.
Next Subtask 3~4b re-evaluate system level code assumptions and simplifications. Due March 30, 2001.

Subtask 3.4e.1 Benchmark CFD methods against 117 scale test data~

ò Completed on schedule - August 2001

ò Conclusion : FLUENT calcs5 with no tuning, show good agreement with data

ò Next milestone (Subtask 3.4.e.2) to develop full scale CFD model for plant calculations~ March5 2002.

SG DPO Action Plan Activities - DBA TIH

Task 3.1 Develop better understanding of potential for damage progression of multiple steam generator tubes due to depressurization accidents (e.g. MSLB)

Scheduled completion 12102

ò AP loads on tube support plates and SG tubes
Flow induced vibrations

Thermal-Hydraulic Issues Related to
Steam Generator Transient Loads

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September 26, 2001

Stephen M. Bajorek
Safety Margins and Systems Analysis Branch
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

DPO Contentions:

(b) Blowdown Forces: Depressurization of the reactor coolant system during a main steam line break will produce shock waves and violent sympathetic vibrations that will cause cracks to form, to grow and unplug, leading to higher leakage from the primary to secondary sides of the reactor coolant system than has been considered by the staff.

(e) Tube Support Plate Lift: Tube support plates can be lifted during the sudden depressurization of a main steamline break and this can cause cracks in tubes to penetrate through the tube walls and lead to additional flow from the primary coolant system to the secondary side of the coolant system.

Background

Depressurization waves propagate at sonic velocity though a fluid media. As depressurization waves move through a system and interact with each other, the AP created causes complex loads and motion in some components.

Typical Velocities

Primary at Tcold:
c(280 C, 15.5 Mpa) = 1074 mIs

Secondary at Operating Pressure:
c(Tsat, 6.55 Mpa) = 1002 mIs (Saturated liquid)
8"- c(Tsat, 6.55 Mpa) = 493 mIs (Saturated vapor)

- Ceebmi
Evaluation Plan:

(1) Initial approach to use hand calculations assuming a I msec BOT and a 3D TRAC-M model of a steam generator to generate a transient pressure history on the secondary side at the tubesheet. The AP(t) across the tubesheet is the forcing function for tubesheet vibration. Goal of the hydraulic effort is to produce a conservative forcing function, AP(t).

(2) The forcing function AP(t) across the tubesheet will be used to analyze tubesheet motion and stresses affecting the tubes. A finite element model of the affected region will be developed and used to determine the transient stresses.

(3) Long-term effort to consider results of (I) and (2):

a) Determine most appropriate analysis tool for investigating SG hydraulic forcing functions.

b) Perform experimental testing and validation as necessary.

Analysis of Steam
Generator Inlet Plenum Mixing using
Computational Fluid Dynamics (CFD)

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Presentation to the Advisory Committee on Reactor Safeguards
September 26, 2001

Christopher Boyd
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research

B aekground

- ò Thermal-hydraulic predictions of plant behavior rely on SCDAP-RELAP5. (lumped parameter code)
- ò Tube temperature predictions during the re-circulating natural circulation phase are directly influenced by mixing parameters which are fixed into the SCDAP-RELAP5 modelse
- ò These mixing parameters are determined from experiments that do not cover the full range of conditions which are of interest to the NRC.

CFD Will Provide...

ò Improved understanding of 117th scale data

ò Extension to full scale

- does scale affect mixing parameters?

ò Effect of tube leakage

ò Effect of inlet geometry variations

- CE plants

ò Tube to tube variations within hot tubes

Schedule I Approach

8/01 ò Validate teclinique through a comparison with Westinghouse 117th scale data (complete).

3/02 ò Extend predictions to full scale using best estimate conditions.

- What is the effect of scale on the mixing parameters?

7/02 ò Complete additional studies.

- What is the effect of tube leakage?
- What effect can inlet geometry have on mixing?
- Other sensitivities...

Quantitative Results (Test SG-S3)

Parameter or Value	Westinghouse 117th Reported Test Data	FLUENT prediction	difference
Heat Loss at Tubes (kW)	3.56	3.48	-2.3 %
# Hot Tubes	75	98	23 tubes
# Cold Tubes	141	118	-23tubes
Th Hot Leg (average Hot T (C))	159.3	149.9	9.4 0C
T~ Hot Leg (average Cold T (C))	86.8	86.9	0.1 0C
m Hot Leg (mass flux (kg/s))	.0599	.0646	7.8%
T~ Tubes (average Hot T (C))	100.8	99.6	-1.2 0C
T~Tubes (average Cold T(C))	64.7	65.6	0.9 0C
mt Tubes (mass flux (kg/s))	.1197	.1088	9.1 %
mt/rn ~ ratio)	2.01	1.7	-15.4%
f (mixing fraction (ref. 2))	0.85	0.91	7.1%

Results of Validation

ò The CFD predictions of parameters are generally within 10% of the Westinghouse 117th scale data.

ò The predictions generally are considered to lie within the experimental uncertainty.
ò The phenomena observed during the tests are predicted by the CFD code.
ò Work on the full scale predictions will proceed with a high degree of confidence in the technique.

Summary

ò The CFD technique has been demonstrated to be applicable for the prediction of mixing parameters.
ò This work provides a high degree of confidence that CFD can be used to evaluate conditions not explicitly covered by the experimental facilities.
ò Further analysis is planned.
- full scale analysis

- tube leakage

- geometry effects

- sensitivity studies

GL 95-05 DPO ISSUES

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SOUTH TEXAS UNIT 2 STEAM GENERATORS

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Briefing of the ACRS Subcommittee on Materials and Metallurgy

September 26~ 2001

Kenneth J. Karwoski~ Division of Engineenng, NRR (301) 415-2752

718" TUBE LEAKAGE DATABASE

ACRS RECOMMENDATION: Database needs to be greatly improved to be useful. Consider requiring a near-term expansion of the database.

Staff agrees that the 7/8" leakage database does not demonstrate as strong a correlation as the 3/4" database

Expansion of the database may firm up the correlation

Licensee committed to periodically remove tubes for destructive examination and data are reflected in the database. Utilities focus on larger voltage indications (i.e., ones that are likely to leak).

No regulatory vehicle in methodology to require removal of additional tubes beyond these current commitments

Staff will continue to monitor the effects of additional data on the correlation

FLAW GROWTH

ACRS RECOMMENDATION: Staff should establish a program to monitor the predictions of flaw growth for systematic deviations from expectations. Develop a database on predictions and observed voltage distributions.

Staff has, and will continue, to review LL9~~~~y reports" submitted by licensees with this in mind

Staff formalizing review of inspection summary reports (including 90-day ODSCC reports) in conjunction with Steam Generator Action Plan Item 1.10

Some instances where predictions were non-conservative either in the number or severity (voltage) of degradation

SOUTH TEXAS UNIT 2 STEAM GENERATOR DESIGN

Westinghouse Model E2 Steam Generators (SGs) - 4864 tubes per steam generator

3/4" outside diameter alloy 600 mill annealed tubes - 15 thermally treated tubes in one steam generator

Drilled hole stainless steel tube support plates (TSPs) - bottom support is a flow distribution baffle
with enlarged tube holes

Similar to Doel 4 and Tihange 3 Steam Generators - no other domestic plants with stainless steel drilled hole TSPs

Tubes hydraulically expanded into tubesheet

Shot peened hot leg at end of 1st cycle and cold leg at end of 2nd cycle

U-Bend heat treatment for RI and R2 prior to operation

Preheater - tubes expanded to reduce ikeli hood of tube wear (high crossflow velocity of feedwater)

STEAM GENERATOR OPERATING EXPERIENCE AT STP 2

T-hot approximately 6250F

At the End-of-Cycle 8 (EQC 8) in March 2001, the SGs were in operation for 8.9 EFPY

Primary degradation mechanism - axial outside diameter stress corrosion cracking (ODSQC) at TSPs

Other degradation mechanisms observed during this inspection and prior inspections

Free span axial QDSCC associated with ding locations (9 at EOC 7, 22 at EQO 8)
16 of 22 in cold leg, most are OD initiated

4 free span volumetric indications in EOC 8

STEAM GENERATOR OPERATING EXPERIENCE AT STP 2 (CONT'D)

New mechanisms observed at EOC 8

9 circumferential indications at hot leg expansion transition - 8 OD initiated, one possible ID indication (in situ tested some indications)

Degradation at paired dings - dings separated by thickness of TSPs and believed to be introduced

during a ~ moment during tube insertion" - 1 circumferential indication at upper ding and axial at lower ding (in situ tested)

Row I U-bend indication - 1 OD initiated axial crack near apex (in situ tested)

Single axial indication at U-bend transition in Row 36 - OD initiated

OD volumetric indication at expansion transition of one of the preheater expanded tubes - possible

foreign part damage

9% of tubes currently plugged

Replacement scheduled for 12/02

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VOLTAGE BASED REPAIR CRITERIA

Implementation of voltage-based tube repair criteria at STP 2

Cycle 7 (1998-1999) - GL 95-05,1-volt repair criteria

Given I-i 31 levels, 15.4 gpm primary-to-secondary leakage could be tolerated during a SLB

Cycle 8 (1999 - 2001) - GL 95-05 1.0 volt repair criteria

Cycle 9 (2001 - 2002) - 3.0 volt locked tube support plate repair criteria
Select tubes expanded at TSPs 2, 3, and 4 to limit TSP motion during SLB
Similar to Braidwood/Byron 1, 3-volt repair criteria

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LEAKAGE DURING NORMAL OPERATION

Steam generator tube leakage observed for first time during Cycle 8

SGA: 10.Sgpd	SGB: 7.5 gpd
SGC: 8.Ogpd	SG D: 9.0 gpd

Secondary side pressure test conducted for 4 days - approximately 100 "damp" tubes located

Leakage attributed to ODSCC at TSPs

No other domestic plant has observed measurable operating leakage from axial QDSCC at tube-to-tube support plate intersections

South Texas 2 is only one with drilled hole stainless steel TSPs

2 foreign plants had drilled hole stainless steel TSPs (Doe 4 and Tihange 3) - during a secondary side pressure test at Doel 4, some leakage was attributable to QDSCC at TSPs

Because of operational leakage, licensee essentially implemented a 1.5 volt repair criteria

Performed plus-point inspections and depth sized to determine tubes that should be preventively plugged

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NRC REVIEW OF SOUTH TEXAS 90-DAY REPORT (EOC 8IBOC 9)

Predicting EOC voltage distributions

Number of indications - POD of 0.6

Severity of indications - growth rate distribution

Correlation of in-situ test results to observed leakage during operation

In-situ tested tubes with most severe degradation

When corrected for operating conditions (e.g., temperature), leakage measured during test does not appear to account for observed leakage

Probability of Leakage Model

Several tubes were udamp~ following the secondary side pressure test - are the results of this test consistent with the probability of leakage model?

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Comparison of Number of Indications Predicted versus Observed
Cycles 6, 7, and 8

Steam Generator	Cycle 6 U997-1998) IL Projected	Actual	Cycle 7(1998-1999) Projected	Actual]	Cycle 8 (1999-2001) [Projected	[Actual
A	322	188	293	330	509	611
B	565	500	836	815	1294	1229
C	437	456	749	602	927	972
D	437	340	558	515	792	767
Total	1761	1484	2436	2262	3522	3579

Observation: For cycle 8 under predicted the number of indications in 2 of 4 steam generators

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Comparison of Severity of Indications Predicted versus Observed
Cycles 6, 7, and 8 (greater than 2 volt indications)

Steam Generator	Cycle 6(1997-1998) Proj	Actual ú	Cycle 7 (1998-1999) ProJ2e%,ed	~- Act	]i[Cycle8 ({~999-2OO1) ProJ2%'ed	J Actual >2V
A	2	4	6	7	18	43
B	1	0	1	8	34	33
C	0	1	2	11	32	41
D	0	1	3	8	24	46
Total	3	6	12	34	108	163

Observation: For cycle 8, under predicted the severity of the "large" voltage indications in 3 of4 steam generators

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Average Growth Rates
Cycles 5, 6, 7, and 8

Cycle	f Duration Period	(EFPD) I	Number of Indications I.	f Average BOC Voltage	1 Average % j Growth per EFPY
5	1995-1997	450	703	0.31	31
6(2RE06)	1997-1998	564.9	1484	0.31	27
7 (2RE07)	1998-1999	342.5	2262	0.41	45
8 (2RE08)	1999-2001	458	3580	0.37	82
9	2001-2002	485(planned)			

Observation: Average growth rate is increasing

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NEXT STEPS

Questions/Issues posed to licensee

Monitoring for operational leakage
None observed presently

Licensee plans to replace steam generators in 12/02